Materials Chemistry Department

Physical and Engineering Sciences Center

Unique Materials Made to Order

If existing materials don't fill the bill, Sandia's Materials Chemistry Department can create a new one to meet specifications. From design through fabrication, we offer an integrated, one-stop solution for developing advanced materials that satisfy rigorous performance criteria. Armed with a deep understanding of how chemical structure and the manufacturing process will affect material behavior, we often design these new products from the molecule up, incorporating desired functionalities to meet our customers' needs.

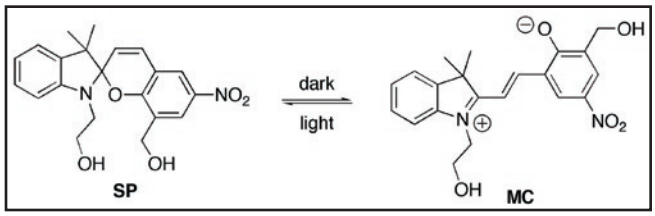
From soft polymers to specialized metal coatings, our inventions stand up to the harsh environments and demanding performance requirements of nuclear weapons, homeland security, and other national security applications.

Of course, our materials find commercial application as well—particularly since we minimize environmental impacts by using the least-toxic ingredients commensurate with performance criteria. Manufacturability is another top concern, and we pride ourselves on practical, affordable solutions.

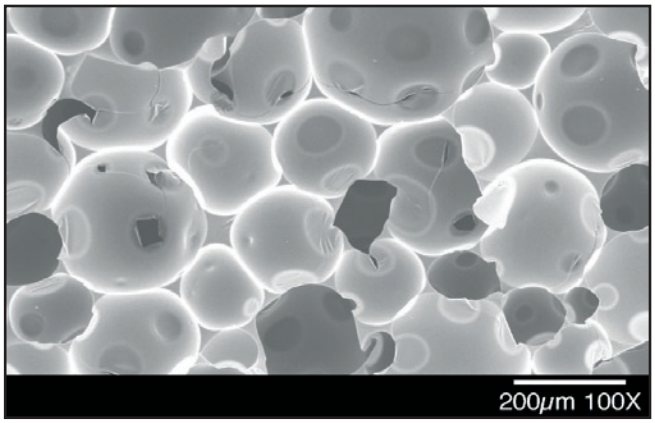
From organic polymers to superalloys, from molecular synthesis through prototype fabrication and test, we welcome the full scope of materials challenges.

Organic and Polymeric Materials

Our chemists and materials scientists bring unparalleled experience to the design of monomers, polymers, and self-assembling dendrimers.



Photoreversible monomer: In the absence of light, the spiropyran (left) transforms into the merocyanine (right). The hydroxyl groups (the attachment points for other molecules) undergo a dramatic shift in configuration—thereby enabling this reversible system to serve as an effective light sensor.



An airy soufflé that won't collapse: Sandia's TufFoam features a rigid, closed-cell polyurethane structure that helps it resist impact damage despite its light weight. Originally developed to protect sensitive electronics in nuclear weapons, TufFoam has potential applications from surfboards to airplane wings.

We specialize in foams of all types: structural, energy absorbing, and chemically functional. TEPIC (patent pending) is a versatile structural foam that retains its shape and strength at temperatures exceeding 400°F at 100 psi. As such, TEPIC can be used as low-cost tooling to manufacture advanced composite materials that call for high-temperature curing—an application that has heretofore required expensive metal tooling. Also awaiting its patent number, TufFoam is an environmentally friendly, energy-absorbing foam that can withstand a wide range of impact scenarios, from blast mitigation to slow-speed impacts. We built in greater toughness by combining rigid and flexible molecular portions into a closed cell structure which TufFoam maintains over its unusually wide density range of 0.032–0.7 g/cc.

Beyond specialty foams, we use our expertise in polymer science to make coating and encapsulation (potting) materials as well as reactive media such as desiccants. Our polymer hydrogen getters—which scavenge unwanted hydrogen from a variety of environments—are commercialized for household and industrial safety applications.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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In another line of research, we are developing responsive polymers, including reversible, self-assembling macromolecules for synthesizing nanomaterials; triboluminescent crystals for use as no-power damage sensors; and thermally cleavable surfactants that promise diverse applications from the biomedical to textile to wastewater industries.

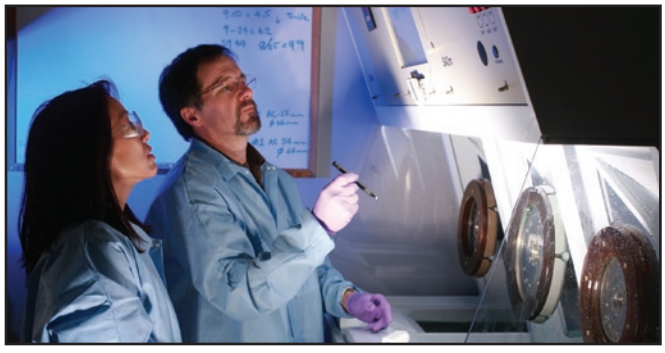
Composite Systems

We maintain a full suite of composite fabrication capabilities, using both hand lay-up and filament-winding techniques to build complex structures that combine high strength with light weight. Automated fabric cutting ensures precise, reproducible dimensions and consistent performance.

High-strength composite armor is made by filament winding. The top photo shows the cable winding; the bottom photo shows the finished glass/cable composite. Because this composite is much lighter than traditional materials of equal strength, parts made from this material will require less manpower to lift and haul.

Plating Solutions

Our complete-capability plating shop can deposit a wide range of metals onto complex surfaces. From specialty plating with high-strength nickel or low-emmisivity gold, to routine copper plating and aluminum anodizing, we apply these metals in strictly controlled processes, with all the precision demanded by tight-tolerance nuclear weapon systems. Reliable manufacturability is a key goal in our process design.



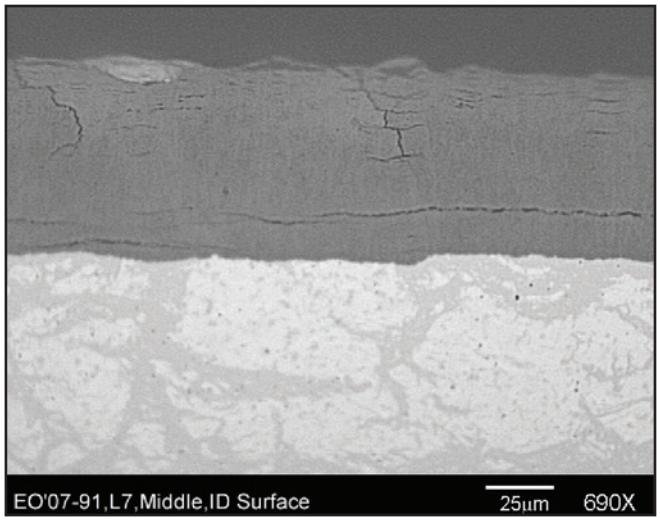
Automated electroplating: Our design engineers and machine shop technologists ensure the right materials are deposited exactly where and when they should be.

Chemical Assessments

Safety and environmental awareness are top priorities at Sandia. Ever mindful, we evaluate our products and processes with an eye to minimizing environmental impacts while satisfying all performance requirements. Our chemists are available to advise on diverse chemical safety and homeland security issues, assessing the potential effects of various toxic releases under different incident scenarios.

Analytical Chemistry

We could never meet our customer's specifications without state-of-the-art analytical tools to assess the quality and performance of our products. We perform chemical (e.g., nuclear magnetic resonance, UV/vis, fluorescence) and mechanical (e.g., dynamic mechanical analysis) characterization ourselves to minimize feedback time in the design process. As needed, we turn to our sister departments in Sandia's Physical and Engineering Sciences Center for modeling expertise and additional analytical capabilities. For example, when it comes time to prove out products such as TufFoam or composite structures, our sister organizations can predict performance and failure thresholds.



Some of our zirconium alloys oxidize almost 500 times faster than conventional Zr alloys. Sophisticated analytical tools allow us to study the mechanisms behind this rapid oxidation. This electron micrograph of an oxidized Zr alloy shows that, despite obvious flaws, the oxide is quite uniform and adherent.

Learn more at: http://public.ca.sandia.gov/8700

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